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AFRL-SR-BL-TR-01-

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1. REPORT DATE (DD-MM-YYYY) 10/05/00		2. REPORT TYPE Final Technical Report		3. DATES COVERED (From - To) 09/29/95 - 03/30/00	
4. TITLE AND SUBTITLE University of Michigan Japan Technology Management Program Final Report US-Japan Industry and Management Training Program September 1995 - March 2000				5a. CONTRACT NUMBER DOD-G-F49620-95-0517	
				5b. GRANT NUMBER C033566	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Jeffrey K. Likcr				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER 221002	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Japan Technology Management Program University of Michigan 1205 Beal Ave., 2715 IOE Bldg. Ann Arbor, MI 48109-2117 Tel: 734-763-3258				8. PERFORMING ORGANIZATION REPORT NUMBER JTMP-FNL-9598-100500	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Col. Jan Cerveney, Program Air Force Office of Scientific Research 801 N. Randolph St, Rm. 732 Arlington, VA 22203-1977				10. SPONSOR/MONITOR'S ACRONYM(S) AFOSR	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Available upon request					
<div style="border: 2px solid black; padding: 5px; display: inline-block;"> RECEIVED OCT 19 2000 BY: <i>[Signature]</i> </div>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The Japan Technology Management Program at the University of Michigan began in late September 1991. The Program operated under three separate grants from the Air Force Office of Scientific Research, the final one from September 1995-March 2000. The program had three major areas of effort: research; outreach and dissemination to industry and the military; and student programs. Major accomplishments of the grant included the publication of two books, the growth and increased importance to industry of the annual Lean Manufacturing Conference, and the increased involvement of students in internship to Japan and in lean manufacturing activities.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 27	19a. NAME OF RESPONSIBLE PERSON Heidi Tietjen
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code) 734-763-3258

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**Japan
Technology
Management
Program**

The University
of Michigan
1205 Beal Ave.
2715 IOE Bldg.
Ann Arbor, Michigan
48109-2117

Telephone (734) 763-3258
Registrations (734) 764-2349
Facsimile (734) 763-0686
Email jtmp@umich.edu



October 9, 2001

Col. Jan Cerveney
Air Force Office of Scientific Research
801 N. Randolph St.
Arlington, VA 22203-1977

Dear Col. Cerveney:

Enclosed is the Final Performance Report for the University of Michigan Japan Technology Management Program (F49620-95-1-0517).

We would like to take this opportunity to thank members of the AFOSR staff for their support and assistance over the past nine years. The US-Japan Industry and Technology Management Training Program is now at an end, but the work we began under the program continues. In reviewing our files to write this report, we were led to recall the many people the program has touched and the difference it has made to students, researchers, and current and future industry leaders.

Sincerely,


Heidi Tietjen
Associate Director

University of Michigan
Japan Technology Management Program
Jeffrey Liker, Director

Final Report
US-Japan Industry and Technology Management Training Program
DOD-G-F49620-95-0517
September 1995 – March 2000

The Japan Technology Management Program began in late September 1991. The program operated under three separate grants from the Air Force Office of Scientific Research, the final one from September 1995 – March 2000. It is this last grant with which this report is mainly concerned. The grant had three major areas of effort: research; outreach and dissemination to industry; and student programs. Major accomplishments of the grant included the publication of the books *Becoming Lean: Inside Stories of Us Manufacturers* (Productivity Press, 1997) and *Remade in America: Transplanting and Transforming Japanese Management Systems* (Oxford University Press, 1999), the growth and increased importance to industry of the annual Lean Manufacturing Conference, and the increased involvement of students in internships to Japan and in lean manufacturing activities.

The Japan Technology Management Program (JTMP) continues to operate using non-AFOSR funds.

RESEARCH

Transfer of Japanese Manufacturing Methods: NSK Corporation Case Study. Professors Jeffrey Liker, Mary Yoko Brannen, and W. Mark Fruin completed a study of NSK's internationalization. NSK is Japan's leading manufacturer of bearings and has been very aggressive about developing manufacturing capabilities in America, Europe and Brazil. The team is focused on three manufacturing operations in the US located in Ann Arbor, Michigan, Franklin, Indiana and Clorinda, Iowa. In all cases NSK has done an exemplary job of transferring their production system with a strong emphasis on quality. Clorinda and Franklin were non-unionized greenfield plants, while Ann Arbor involved the renovation of an existing unionized plant. This study looked at the process of transfer of NSK's manufacturing management approaches, as well as how those approaches have been adapted to the specific situation of each of these American plants. The research included visits to NSK's headquarters in Japan and Japanese sister plants to the Ann Arbor plant. The study was partly funded by the AFOSR grant but was most funds came from the Tauber Manufacturing Institute at the University of Michigan. The study has

resulted in several presentations at national conferences (INFORMS, Academy of Management, Association of Japanese Business Studies) and a chapter in the book *Remade in America*. These and other publications resulting from JTMP research are listed in Appendix I.

Impact of JIT Requirements on American Parts Suppliers: Sloan Trucking Center Study - The Sloan Foundation sponsored a large trucking center grant at the University of Michigan. The purpose is to conduct research on the trucking industry and disseminate best practices. Professor Jeffrey Liker is working with students and other faculty to study the impact of just-in-time manufacturing on the trucking industry. In October 1996 they went on a study mission to Japan and visited Toyota and several affiliated parts suppliers and trucking companies. They are examining how just-in-time manufacturing is being implemented by US auto companies and Japanese manufacturers in North America and how parts suppliers are organizing to ship parts JIT to their U.S. and Japanese customers. Building on research conducted during all three JITMT grants *Designing Across Organizations: Concurrent Engineering through the Supply Chain*, a volume written by Jeffrey Liker with Mitchell Fleischer of the Industrial Technology Institute, was published by Hanser-Gardner. The book covers conceptual issues, case examples, and a methodology for redesigning the organization to more effectively integrate across the organization and across companies for concurrent engineering. The methodology includes an extensive set of forms for analyzing the current organization and designing an appropriate future organization. Both *Designing Across Organizations* and *Remade in America* draw extensively on the research by Professor Liker and associates under the AFOSR grant on Japanese approaches to concurrent engineering through the supply chain.

Professor Liker co-edited a special issue of *IEEE Transactions* on engineering management with David Gibson of the University of Texas, Austin. *IEEE Transactions*, which has about 10,000 subscribers, is the leading peer-reviewed academic journal on engineering management. The topic of the special issue was "Technology Management and the Asia Pacific." While the topic broadly covers the entire Asia Pacific, more than half of the papers focused on technology management in Japan.

Knowledge Conversion in Japanese Companies -- The basic theme of the research by David Methe, then Assistant Professor of Corporate Strategy at the University of Michigan Business School and currently on the faculty at Sophia University in Tokyo, concerns the processes involved in how Japanese organizations create technological knowledge and convert that knowledge into products. In conducting this research, Prof. Methe examined the establishment of basic research facilities in Japanese electronic companies. He also examined the product development efforts of Japanese electronic companies in the personal computer industry and studied the efforts at globalizing research that Japanese electronic and pharmaceutical companies are currently carrying out. The knowledge gained from these research projects was combined with other research on Korea companies. Prof. Methe's research into Japanese companies was conducted in Japan in the summers and involved in-depth interviews of executives and

top researchers of the leading electronic companies. Several papers building on his research are listed in Appendix I.

Supplier Involvement in Product Development -- As companies restructure to focus on their core competencies and outsource large subsystems to suppliers a natural progression is to give suppliers responsibility for designing their own subsystems. This places the OEM in the role of system integrator. Managing what has come to be called "full service suppliers" is fundamentally different than managing suppliers of make-to-print components. The U.S. and European auto industries have been aggressively moving to transform supplier relationships closer to the Japanese model.

Publications from early research under the JTMP focused on the role of suppliers in product development in the Japanese automotive industry. Seeking to answer the question of how these practices are transferred and transformed within the U.S. automotive industry, this on-going study by Jeffrey Liker and Industrial and Operations Engineering graduate student Young Ro involves benchmarking U.S., European, and Japanese automakers to compare how customers and suppliers are coordinating their product development efforts. The research method is in-depth interviews with engineers in automakers and first-tier suppliers focusing on a small number of major subsystems (e.g., chassis, interior systems). The study is being done in collaboration with Renault. Renault has sent a full-time engineer for IOE to work on the project.

The Roots of Lean -- At the center of JTMP's research and coursework has been Japanese manufacturing systems, and in particular, what have come to be called in America "lean manufacturing methods." The Toyota Production System is at the core of many of the best Japanese practices and versions of TPS are being disseminated throughout U.S. industry. Thus, the 1990s have seen the development of numerous imitations of the Toyota Production System by America's leading manufacturers, including the Ford Production System, the Chrysler Operating System, the Delphi Manufacturing System, the Aeroquip Production System, among many others.

In looking at the development of TPS it is surprising to many that its roots can be traced to the United States. However, it is also clear that much of the innovation in this system of production was developed in Japan through years of trial and error. This research by John Shook traced the roots of the development of modern Japanese operations management by identifying and analyzing the transfer of specific operations management practices from the U.S. to Japan in the post-war period. The researcher is well qualified to undertake this research. John Shook worked for Toyota in Japan from 1983 to 1991 assisting the company in transferring the Toyota Production System to the United States. He speaks and reads Japanese and is an authority on the concepts in question. Mr. Shook made two trips to Japan to visit the Toyota archives and to interview current and retired Toyota engineers and executives about the development of TPS.

Concurrent Engineering and Product Development -- Dr. Allan Ward hypothesized that concurrent engineering, which involves initiating the later stages of design before the logically previous steps have been finished, should be done by communicating sets of possibilities. For example, the product engineer who has not yet determined a single

design solution must communicate to the manufacturing engineer the set of possible solutions so the manufacturing engineer can critique the design and begin preliminary development of the manufacturing system. Prof. Ward suspected that Japanese companies, renowned for their short development lead times, are using a more set-based approach that we see in the United States. Working with Jeffrey Liker and PhD students Durward Sobek and James Lin, Dr. Ward tested whether this is true and sought to understand how it is done in the Japanese automobile industry. A major focus was on how specification were communicated by automobile OEMs to their components suppliers who are responsible for part design and how the supplier communicate to customers their capabilities and potential tradeoffs in performance, cost, and weight targets. Prof. Ward applied his observations and findings to the aerospace industry, working with the FXS team at Wright Patterson Air Force Base. Prof. Ward left the University in 1997 and so discontinued his formal research relationship with the JTMP, but continued to work with the automobile industry and Air Force to refine his ideas and apply them to manufacturing.

Faculty Small Grants Program -- Much of the research focus on the Japan Technology Management Program has been on manufacturing and product development by Department of Industrial and Operations Engineering faculty and students. To encourage faculty in other departments working on other topics to widen their scope of inquiry to include Japan, the program offered small research grants. These could be used to support direct research expenses or to fund travel to Japan to meet with Japanese researchers. During the grant period we supported six projects.

- Lumin Wang, Associate Research Scientist, Nuclear Engineering and Radiological Science, Study of Radiation Effects in Nuclear Materials with in situ TEM. Funds were used to travel to Japan to conduct ion irradiation experiments including dual-beam ion irradiations with in situ high resolution transmission electron microscopy (TEM) analysis on several important nuclear materials in the Japan National Institute for Metals and the Japan Atomic Energy Institute. The results of these experiments are valuable for the long term safe operation of nuclear reactors and also for the assessment of long term environmental impact of nuclear waste disposal in geological repositories.
- Franco Nori, Associate Professor, Physics, Transport Phenomena in Materials. Funds were used for travel to Japan to collaborate with scholars at Hitachi's Advanced Research Laboratory and the Applied Physics Department of Hokkaido University on the study of the transport of magnetic flux lines, electrons, and phonons in a variety of materials.
- Mark Banaszak Holl, Assistant Professor, Chemistry, A Study of Silicon-based Microelectronics in Japan, Particularly the Silicon/Silicon Oxide Interface. Funds were used for travel to three Japanese universities to learn new techniques, discuss the best interpretation of data, and to establish collaborative projects.
- Hwai-Chung Wu, Research Investigator, Civil and Environmental Engineering, Applications of Advanced Fiber Reinforced Plastics in Construction. Funds were used to travel to Japan to research the applications of FRPs in a civil engineering context (particularly bridges) and to initiate potential collaboration on application

of advanced fiber reinforced plastics in civil engineering with the Kajima Corporation's construction laboratory.

- Dimitris Pavlidis, Professor, Electrical Engineering and Computer Science, Heterojunction Bipolar Transistors Using III-V Nitride Materials. Funds were used for research assistance and supplies in the United State and then for travel to Japan to consult with Prof. Isamu Akasaki at Meijo University, who has conducted pioneering work on III-V nitride growth. Prof. Pavlidis's research addressed the evaluation and first demonstration of electronic devices based on III-V nitride semiconductor materials and their use for electronic devices such Heterojunction Bipolar Transistors (HBTs).
- Yorem Koran, Professor, Mechanical Engineering and Applied Mechanics, An Analysis of the Domination of Japanese Computer Numerical Controllers. In the late 1980s and early 1990s Japanese companies overtook American companies to dominate the world market in industrial control systems. This study analyzed some of the main reasons for Japanese dominance of and American decline in this arena, as well as the technological and market evolution of Numerical Controls and Computer Numerical Control technology.

OUTREACH TO INDUSTRY

The Japan Technology Management Program continued its outreach to industry during the reporting period. Unless free and open to the public, these activities were financially supported through registration fees but we have included them here as they built upon the research and activities funded by the JITMT grant during the past eight years. Brochures from each of these activities are attached at the end of this document.

Lean Manufacturing Conference – In 1995 the Japan Technology Management Program ran its first Lean Manufacturing Conference. We were expecting an audience of 30-50 people. More than 100 people showed up. Each year since that first conference held in Sterling Heights, Michigan, the conference has grown, until in May 2000 attendance was at 500 people. The conference director each year has been John Shook. In 1999 and 2000 the Japan Technology Management Program partnered with the Lean Enterprise Institute. Students help with the coordination of the conference and to keep things flowing smoothly during the event. We also allow University of Michigan faculty, staff, and students to come at a below-cost price and give a 50% discount to students and faculty from other institutions. Members or employees of the military pay the same registration fee as members of the University of Michigan community.

Its first year the conference, entitled "Getting to the Core," had a modest one and a half-day agenda combining research findings by JTMP faculty and students and one guest speaker, Russ Scaffede, a lean manufacturing consultant, formerly of General Motors and Toyota and soon to be at Donnelly Corporation. The second conference, held in May 1996 with an audience of 200 people and entitled "Are We There Yet?," moved away from the more academic model of the first year and brought in a host of speakers from the Big Three automakers, the GM-Toyota joint venture at NUMMI, and several supplier companies. The keynote speaker was Jim Womack, president of the Lean Enterprise

Institute and co-author of the groundbreaking book *The Machine that Changed the World*. In 1997 we again focused on the automobile industry and added an optional half-day seminar on "What Is Lean Manufacturing?" to introduce newcomers to the basic concepts of the Toyota Production System. Mike Rother led this seminar. The conference took as its theme, "Is Fixing the Plant Enough?" and had a mix of speakers from automotive OEMs and suppliers, as well as James Womack.

The 1998 conference, "Focusing on the Value Stream," allowed us to introduce the concept of "value stream mapping" to the audience. VSM is a tool used to look at the current flow of materials within a value stream (this can be a production facility, a company, or entire supply chain) and to determine where waste or inefficiencies occur. This is called a "current state map." The mapper then uses this current state map to create a "future state map" to show how non-value-added activities can be decreased. This conference also marked the beginning of breakout sessions at the Lean Manufacturing Conference, concurrent sessions on specialized topics. Mike Rother held two value stream mapping workshops, Al Ward, at that time an adjunct University of Michigan researcher, led a session on the Toyota product development process, based on his largely JTMP-funded research; Marty Anderson of Babson College applied lean principles to the distribution process; and consultant Tom Luyster did a high energy JIT-Heijunka simulation. The final day of the conference focused on the "lean" stories of three companies featured in Jeff Liker's book *Becoming Lean*.

By the 1999 conference ("Lean Thinking for the Auto Industry") we assumed most people at manufacturing firms were familiar with the basic concepts of lean manufacturing and so we changed our day one seminar to "Making Lean Happen in Your Plant." Mike Rother was joined by consultants Tom Luyster, Rick Harris and Chuck Ward to teach value stream mapping and other hands-on tools for implementing lean manufacturing. In addition of conference regulars John Shook and James Womack, Rodney O'Neal, President of Delphi Interior Systems, Kunihiro Masaki of the Toyota Technical Center, and Robert Cole, of the University of California-Berkeley spoke. Breakout sessions covered issues of product development, process engineering, value chain management (covering planning and logistics and supplier development), production control, management accounting, and human resource issue involved with managing the plant. As opposed to the previous year's single-speaker breakout sessions, sessions in 1999 took a panel format, with at least two presenters in each session.

The 2000 conference, although officially outside the scope of this report, was entitled "Lean for the 21st Century Auto Industry." We abandoned the optional day one seminar and opted for a full day of breakout sessions. The first day of the conference took as its theme "Meeting the Order-to-Delivery Challenge." John Shook and James Womack were joined by representatives from Ford, Delphi Automotive Systems, and Transfreight, and Yoshinobu Yamada, a consultant who had a long career as general manager of production control at Toyota, and Jeffrey Liker. Breakout sessions covered value stream mapping, creating continuous flow, creating pull, macro-value stream mapping, supplier development, process and product development, managing lean implementation projects, and people systems for lean. The third day, "Lean Management, Lean Leadership, Lean Change," featured a talk on John Shook on Japanese management philosophies and their

applications in American companies, Maria Stopher on NIST's lean outreach program, George Koenigsaecker on managing lean change, and James Womack on creating a lean enterprise.

We have videotaped all or part of the conference since 1997. These videotapes are for sale to the public.

Executive Seminar on Lean Manufacturing -- In 1998 and 1999 the JTMP held a seminar aimed at the top leaders and implementers of lean manufacturing in companies. Enrollment was limited to 30 people, with two people from each company. The goal of the seminar was help companies develop a system-level understanding of lean manufacturing, focusing on the flow of material and information through the enterprise, and to enhance the implementation skills of the executives involved. The seminar was highly interactive with simulations demonstrating key concepts, hands-on use of tools for mapping the value stream at an actual production facility, and in-depth discussion of implementation issues led by experts with shop-floor implementation experience. The seminar was led by Mike Rother and John Shook, with a simulation session by Tom Luyster. In 1998 James Womack and Art Smalley of Donnelley Corporation joined as guest speakers. In 1999 Frank Cooney of General Motors Corp. and Russ Scaffede of Donnelly Corporation spoke.

Lean Manufacturing Program -- The JTMP teamed with the Center for Professional Development in the College of Engineering to create the Lean Manufacturing Program, a ten-day program leading to the Lean Manufacturing Noncredit Certificate of Completion. Participants can choose to take individual courses without obtaining the certificate. The program covers an overview of lean manufacturing, lean system design, supporting lean tools and methods (e.g. information technology, job instruction training, cell analysis, designing standardized work, and design, rapid plant assessment), and leadership and team management tools (e.g., accounting and measurement, developing and leading work groups, and leading change) The classes are taught by University of Michigan faculty, including Jeffrey Liker, and outside consultants, many of whom worked for Toyota. The program is run six times a year in Ann Arbor and Grand Rapids, Michigan, as well as in other venues such as Florida, Virginia, and California.

Videotape on Lean Manufacturing -- The Japan Technology Management Program embarked on a project to produce a short video to introduce the basics of lean manufacturing to corporate and academic audiences. Although some headway was made with the project, it was still in the early stages when several other groups came out with a similar videotape and the project was shelved. Instead, Prof. Jeffrey Liker collaborated with the Society of Manufacturing Engineers to produce a videotape on Value Stream Mapping. That videotape is currently on sale and available to the public.

Management Briefing Seminars -- The JTMP partnered with the College of Engineering to hold three conferences and workshops that were spin-offs of our work on lean manufacturing in Traverse City, Michigan in August 1996. The first "Financial Management of Lean Manufacturing" conference was attended by 60 industry executives. A half-day workshop called "Factory Layout for Lean Manufacturing" drew about 25 participants. Also, a third offering of "Integrated Product-Process Development" was

offered with the theme "Engineering for Lean Production." This two-day course drew about 125 participants. Prof. Jeffrey Liker continued to run courses based on JTMP-sponsored research at the Management Briefing Seminars in subsequent years, including: "What is Lean Supply Chain Management?", "Achieving Balance in Toyota's Integrated Development Process," "Lean Supply Chain Management," and "Integrated Product-Process Development."

Negotiating with the Japanese -- Established by the University of Michigan's East Asia Business Program in 1988, we continued to run this executive training program until 1998. The course consisted of two days of lecture and discussion on the Japanese business system, negotiating style, and tactics, followed by a day of mock business negotiation and review. We usually had at least two Air Force personnel take part in the course.

Academic and Professional Society Conference Presentations -- The JTMP director, Jeffrey Liker, and his graduate students made numerous presentations on their research at academic and professional conferences. Presentations by Prof. Liker included:

- "Supplier involvement in Design: How far have we come?," invited paper session, Technology Management Section, Spring, 1999, INFORMS, Cincinnati.
- "Lean Supply Chain Management," Tutorial Session, Fall, 1998, INFORMS conference, Seattle.
- "An investigation into best-practice usage of Quality Function Deployment in the US and Japan," invited paper session, Technology Management Section, Fall, 1998, INFORMS conference, Seattle (with J. Cristiano).
- "What is Lean Supply Chain Management?" Lean Supply Chain Management, UM-Society of Manufacturing Engineers (SME) joint conference, Troy, Michigan, Nov. 1998.
- "Becoming Lean: Implementation Lessons," Society of Manufacturing Engineers Conference, Nashville, Tennessee, May, 1998.
- "Set-based Engineering and Supplier Involvement in Design," Conference on Supplier Involvement in Design, Darden School, University of Virginia, April 24-25, 1998.
- "Recontextualization and Factory-to-Factory Knowledge Transfer at NSK," invited paper session, Association of Japanese Business Studies, Chicago, May, 1998 (second author with Mary Yoko Brannen and Mark Fruin).
- "Information Flows & Prototyping in Automotive Body Development: Toyota vs Big-3," invited paper session, Technology Management Section, Spring, 1998, INFORMS conference, Montreal (with J. Morgan).
- "What do we know about Japanese product development," invited paper session, Technology Management Section, Fall, 1997, INFORMS conference, Dallas.
- "A methodology for reengineering for product-process integration," invited paper session, Technology Management Section, 1997, INFORMS conference, Dallas (with M. Fleischer).

- "Recontextualization and knowledge transfer from Japanese to U.S. factories," invited paper session, Technology Management Section, 1997, INFORMS conference, San Diego (with Mary Yoko Brannen and Mark Fruin).
- "Concurrent engineering, lean manufacturing, and supplier involvement," invited paper session, Technology Management Section, 1996 INFORMS conference, Wash. D.C.

Durward Sobek, a doctoral student whose research we supported on previous rounds of our grants as well as during this supporting period, worked with Jeffrey Liker and Allan Ward on product development research. Now an assistant professor at Montana State University, Prof. Sobek actively disseminates his research findings:

- "The Role of Intermediate Representations in Engineering Problem Solving," Proceedings of the 62nd Annual ASME Pacific Northwest Section Meeting, April, 2000.
- "Toyota's New Conventional Wisdom," 1998 INFORMS meeting held in Seattle, WA, based on the Harvard Business Review article, "Another Look at Toyota's Integrated Product Development." A version was also presented at the 1998 Implementation Road Map conference held by D.H. Brown and Associates in Dearborn, MI, and will be presented at the 1999 United Technologies Engineering Coordination Activities (UTECA) conference in Cromwell, CT.
- "Integrating Manufacturing Process Design and Product Design: The Toyota and Chrysler Models," 1997 Association of Japanese Business Studies meeting in Washington, D.C. (received *Young Scholars Award*), and the 1997 INFORMS meeting held in Dallas, TX.
- "Principles of Set-Based Concurrent Engineering," with Allan Ward, 1996 ASME Design Theory and Methodology Conference, Irvine, CA; received *Best Paper Award*.
- "Set-based Design and Body Engineering Examples from Toyota," 1996 International Body Engineering Conference, Detroit, MI; invited speaker.
- "A Set-Based Model of Design: The Case of Toyota," 1996 National Design Engineering Conference, Chicago, IL; invited speaker. Also appeared as a feature article in *Mechanical Engineering Magazine*, July 1996.

Industry Conference Presentations In fulfillment of its mission to transfer its research findings to industry, JTMP members actively participate in conferences and meetings geared to practitioners. John Shook and Mike Rother present each year at the Lean Enterprise Institute's Lean Summit, at Productivity Inc. lean conferences, and at the University of Kentucky annual lean conference. Lean Manufacturing Conference. Jeffrey Liker, is much sought out as a speaker. A few of his and other engagements are listed below:

- Chrysler Lean Manufacturing Leadership Institute, U.M. short course, November 1998.
- Society of Manufacturing Engineers "Fundamentals of Lean Manufacturing," Nashville, Tennessee, May 19, 1998 (by Charles Standard, U.M. graduate student)
- Society of Manufacturing Engineers "Building Confidence in Lean Manufacturing," May 20--21, 1998.
- Society of Manufacturing Engineers "Lean Supply Chain Management," (Chair: Jeffrey Liker), Troy Somerset Inn- October 12-14, 1998.
- Society of Manufacturing Engineers "Lean Supply Chain Management," (Chair: Jeffrey Liker), Troy Somerset Inn- October 12-14, 1998.
- Lean Supply Chain Management, Troy, MI, Chair, Oct. 12-14, 1998.
- Best of North American Conference: Becoming Lean, Productivity Inc., Chicago, Nov. 4, 1998 (Keynote Speaker; 400 attendance)
- Best of North American Conference: Becoming Lean, Productivity Inc., St. Louis, Oct. 28, 1999 (Keynote Speaker; 400 attendance)
- Industry Week Best Plants Conferences 1999
 - Los Angeles, May 9 (150 people)
 - Chicago, April 15 (300 people)
 - Orlando, June 2 (500 people)
- 9th Annual Work Cells Symposium, Phoenix, May 27 (100 people)
- Industry Week Growing Companies conference, Orlando, June 4, 1999.
- Institute of Advanced Manufacturing Sciences, Annual Member Company Briefing on Lean Manufacturing, Cincinnati, February 17, 1999.
- Cleveland Advanced Manufacturing Program, Annual Member Company Briefing on Lean Manufacturing, Cleveland, Ohio, November, 1999 (400 people plus satellite downlink to remote sites).

Training Trainers -- The JTMP formed a partnership with the Industrial Technology Institute and the Michigan Manufacturing Technology Center in Ann Arbor. Under the agreement, JTMP makes available training materials, training, and consultation pertaining to lean manufacturing and ITI will then provide training to small to medium sized Michigan manufacturers, greatly extending the reach of JTMP's influence. ITI may also make the materials and training available to the other 175+ Manufacturing Technology Centers nationwide.

Corporate Consultation -- While not supported with grant funds, JTMP-sponsored research and training has allowed our faculty and affiliates to take our results directly to companies as consultants. We see this as part of our mission of educating industry about Japanese management of technology in general and Japanese manufacturing specifically, as well as helping industry implement practices that will strengthen them. JTMP associates also speak a wide variety of industry conferences and meetings. John Shook

and Mike Rother are regular presenters at the Lean Enterprise Institute's annual Lean Summit. John Shook regularly spoke at the University of Michigan's Manufacturing Executive Program on Japanese manufacturing systems and made presentations to industry groups. Corporate clients have included Ford, General Motors, Delphi, Visteon, Donnelly Corporation, Mechanical Products, and Aeroquip. We also worked with these companies on occasion to place student teams completing lean manufacturing projects.

OUTREACH TO THE MILITARY

The Japan Technology Management Program continued to serve the military, especially the Air Force. Employees of the armed services were given free or below-cost admission to JTMP events such as the Lean Manufacturing Conference and Executive Seminar on Lean Manufacturing, and the East Asia Business Program seminar Negotiating with the Japanese. In addition, we sent several JTMP staff or affiliated consultants to work with personnel at Wright Patterson Air Force Base on applying value stream mapping and other lean manufacturing tools to non-production situations and on the lean product development process. Mike Rother and Allan Ward each made a trip to Dayton to consult at WPAFB and Charles Standard, a former graduate student in Industrial and Operations Engineering, traveled there several times. Mr. Standard also presented at Cycle Time Reduction workshop organized at WPAFB. Allan Ward conducted a satellite seminar with WPAFB personnel and Air Force contractors. Currently, Prof. Jeffrey Liker is applying knowledge learned through JTMP research to the shipbuilding industry under a sub-contract grant from the Office of Naval Research.

PROGRAMS FOR STUDENTS

Internships in Japan The Japan Technology Management Program emphasized the effectiveness of direct experience as a means of learning about Japanese industry and worked to place American interns in Japanese companies. In the first years of its existence, the JTMP worked directly with companies and other institutions to place interns during the summer months. Through ties to Toyota, Aisin Seiki (a Toyota supplier company), Sumitomo Light Metals, Long Term Credit Bank of Japan Research, Inc., and several other companies, we were able to place 4-6 interns a year and also gave travel support to students who found internships on their own. (Appendix II lists the students supported, their field of study, and institution, and their host company.) The short duration of these internships—sometimes only six to ten weeks—allowed students to get a feel for working in a Japanese firm and to practice their Japanese language skills, but often did not allow them to get very involved in the projects to which they were assigned. The firms were reluctant to take students for longer periods of time due to resource constraints. In 1997, the continued economic recession in Japan forced Aisin Seiki, Sumitomo Light Metals, and Long Term Credit Bank of Japan Research, Inc. to discontinue their internship programs. Toyota changed its internship focus from accepting a few foreign students for two-month internship to accepting Japanese nationals educated at foreign universities for month-long internships.

Fortunately, in 1996 the Japanese Ministry of International Trade and Industry established an internship matching program. Under the direction of the Japan External Trade Organization (JETRO), the program recruits Japanese host companies and matches them to interns recruited by American universities. The program originated with the schools funded under the AFOSR US-Japan Industry and Technology Management Training Program but has since expanded to include schools in Canada and the United Kingdom. The internships in JETRO program tend to be for six months to one year and often require students to have completed their undergraduate degree. The University of Michigan has taken part in the program since its inception, when it placed one student, Andrew Filip, at Nissan Aeronautical and Space Laboratories for six months in 1997 (he had studied at Nagoya the previous six months, so delayed the start of his internship for several months.)

The following year, the JTMP opened the program to students at any state of Michigan schools, and had two students accepted for internships, both from Michigan State University. In 1998, we further advertised the program to both public and private schools within the state of Michigan. A total of four students were accepted to the program, two from the University of Michigan, one from Lake Superior State University in Sault Ste. Marie, Michigan and one from Michigan Technological University in Houghton.. In 1999 we expanded our scope to accept students from any institutions within the states of Michigan, Ohio, Illinois, and Indiana and sent email messages about the program to faculty and administrators at schools with Japanese language, study abroad programs, or engineering degree programs. We received a total of 27 applications, although a number of those did not meet the minimum requirements for the internships so were not forwarded to JETRO. Ultimately, nine students were placed, although two were not US citizens or permanent residents (and grant funds were not used for their support). Four of these students were from the University of Michigan, and we had one each from the University of Michigan-Flint, the University of Akron, Ohio State University, Earlham College, and Morehouse University in Atlanta, Georgia. Although these students started their internships after the close of the grant, grant funds were used for the promotion and administration of the program before the grant's end. In 2000 we have also included schools in the state of Wisconsin.

In summer 1998 the JTMP conducted a four session "Internship Orientation Seminar" and invited the three students who were attending the Summer Intensive Japanese Language Program and had internships beginning for fall, as well as other students who thought they might want to intern in the future. Heather Clement, a student who had interned at Aisin Seiki in 1997, coordinated the sessions. JTMP co-directors John Shook and John Campbell and past intern Andy Filip presented sessions at the seminar on the social and cultural background of Japanese business, working within the Japanese business system, and tips for living and traveling in Japan.

Interns under the University of Michigan program and recent JTMP alumni working or studying in Japan have participated each year in the JITMT Internship Workshop, supported by the AFOSR grant and organized by one or more of the JITMT schools. These workshops give the students to hear from experts and to network with their peers. Students have been enthusiastic about the workshop each year, although we have found

its value is greater for those students with less extensive exposure to working and living in Japan. It is most useful to students to attend the workshop at the beginning of their internship.

Qualitatively how can we evaluate the internships? The quality of the experience varied greatly, from company to company, from supervisor to supervisor, from student to student. Looking back over the past eight years, in general we conclude that engineering internships in which the interns is given a specific project with defined goal on which to work are the most successful, whether the students are at the company for three months or twelve. Business internships have been less successful, perhaps because it has been more difficult to give the interns a defined task that they can accomplish with their limited language ability. In the year 2000 we have one student placed at the Bosch Automotive Parts (formerly Zexel) in a sales and marketing position. We hope with the longer length of his internship and a defined project (developing marketing materials for non-Japanese companies) the student will be able to make more of a contribution to the firm.

JETRO has been very responsive to the suggestions of the participating schools and the interns in working with companies to improve the program. We have noticed a steady increase in the caliber of the internships as the companies involved become accustomed to hosting interns and recognize the capabilities of the students sent to them. Although the stipends paid to the interns is usually below what they would be paid at American companies, it is considered quite high by Japanese standards. We were at first uncomfortable agreeing that interns should be paid a stipend of at least Y150,000 per month in addition to housing. We know see that those companies willing to make this substantial economic commitment also intend to take advantage of the talents of the interns rather than having them spend their time as observers. It is a win-win situation for students and companies.

After their internships are over, most of the students have said that they would like to return to Japan to work, although most have said they would like to return to work for an American company, not a Japanese company.

The Japan Technology Management Program also collaborated with the University's Tauber Manufacturing Institute to place two students with Alcoa Corporation where they conducted an international study of that company's manufacturing systems, comparing it with world-class manufacturing systems such as Toyota Production System. The JTMP director oversaw the study directly. Alcoa judged the study to be extremely helpful and was so pleased by the caliber of the work they offered both of the students full-time, permanent positions upon their graduation.

In addition to placing students in internships at Japanese companies, the JTMP has assisted a few students in finding internships at Japan-related companies in the United States or at American companies in which they can use the skills they learned in Japan. One industrial engineering student, Paul Carbonneau, interned at Aisin Seiki in the summer of 1996. He was asked to write an English-language guide to give to non-Japanese visitors to the Aisin Seiki brake plant. In order to do this, Mr. Carbonneau had to intensively study the production process used by Aisin Seiki. As a major Toyota

supplier, Aisin Seiki uses its own version of the Toyota Production System. By the time he left Aisin, Mr. Carbonneau had an excellent understanding of TPS.

The following summer John Shook introduced Mr. Carbonneau to Donnelly Corporation, a Holland, Michigan-based producer of windshields and automobile mirrors. Donnelly had been struggling financially and recently had hired two managers to revamp their production system. Both of these leaders had worked for Toyota, one in Georgetown, Kentucky and one in Japan. They determined to institute a version of the Toyota Production System at their Holland facility. Mr. Carbonneau joined their team and examined the production processes to see where waste could be eliminated and work could be made more efficient. Improvements he suggested and helped implement resulted in more than \$150,000 in savings for the company. More importantly, he worked with line supervisors and workers to implement these changes. One of the hardest parts of changing from traditional to lean manufacturing is opposition from workers who fear the changes will eliminate their jobs. Part of Mr. Carbonneau's job was to help the workers understand the new system and to understand that it would increase their job security by making the plant more productive and profitable. He was so successful in the tasks assigned to him that Donnelly hired him as a consultant to work with them on a part-time basis throughout the school year.

In 1998 Mr. Carbonneau took a position with the lean manufacturing team at Connecticut-based Wiremold Corporation, also assisting with the implementation of lean manufacturing within that plant. He was introduced to Wiremold by John Shook.

Another industrial engineering student, David Ostreicher, was supported by the JTMP to study for one year at Kyushu University. Upon completion of his studies there, we were able to place him in Toyota's one-month internship program. He then spend some additional time in Japan interning at another Japanese power company. He returned to the United States mid-semester and wanted to find work that would enable him to use both his industrial engineering and Japanese skills. The JTMP introduced him to a contact at the Toyota Technical Center in Ann Arbor, Michigan, and he spent the next few months working at TTC.

Lean Manufacturing Study Tours -- As mentioned earlier in this report, the Japan Technology Management Program determined that one of the most important aspects of technology management in Japan is the lessons to be learned from the Toyota Production System, it has conducted a number of tours of the Toyota facility in Georgetown, Kentucky and Toyota supplier companies located near Georgetown. The first of these tours was conducted by the University's Tauber Manufacturing Institute (TMI), a joint business-engineering program for graduate and undergraduate students, in 1996. TMI took about 50 students to visit the Toyota plant in Georgetown, Kentucky and the Honda plant in Marysville, Ohio. The JTMP contributed some funds to offset the cost of this trip. At about that same time, Prof. Liker took a group of American manufacturing managers on a tour of the Toyota Georgetown plant and Summit Polymers, a supplier company. Four Industrial Engineering graduate students were included in the tour and the JTMP paid their travel costs.

The above two trips paved the way for the JTMP's annual Lean Manufacturing Study Tour. Open to students, faculty, and staff at the University of Michigan campuses in Ann Arbor, Flint, and Dearborn, the tour has been filled to its capacity of 56 people each year. The seminar takes place at the beginning of the University's spring break at the end of February or beginning of March. We begin with a half-day seminar on lean manufacturing on the College of Engineering campus and then take a bus to Kentucky. In 1998 and 1999 the seminar was taught by Mike Rother and we visited the Toyota plant and Johnson Controls (a seat manufacturer) in Georgetown and Summit Polymers (makers of air vents, cup holders, dashboard components and other polymer items) in Sterling. In 1999 Wayne Ripberger, then vice president of production at Toyota addressed the group at dinner. In 2000 the seminar was conducted by Bill Costantino, an independent lean manufacturing consultant and Toyota veteran. We visited TrimMaster (a joint venture company of Johnson Controls and a Japanese partner) and a Tower Automotive stamping plant in Bardstown, Kentucky, as well as Toyota in Georgetown. As a dinner speaker we had John Allen, former director of human resources at Toyota, who addresses the human factor in lean manufacturing. The tour has been so successful and of such benefit to the students and faculty that it is one of the activities that we plan to continue without AFOSR support.

Fellowships -- From its inception, the JTMP offered support to students. This was divided broadly into research assistantships (covered under research) and into fellowships. The fellowships fell into three categories, although we also tried to maintain flexibility in order to best meet the needs of our students. First, we offered summer language study fellowships to study in the University's Summer Intensive Japanese Language Program or in a similar program in Japan. Second, we offered academic year support to graduate students in science, engineering, or business so that they could take a year to pursue Japanese studies, including language. Third, we offered research support fellowships to graduate students pursuing research on Japan or Japan-related technology management topics. These latter fellowships did not require the students to study the Japanese language. Appendix III gives a chart of the students and their support.

The summer language fellowships were open to undergraduate and graduates students at the University of Michigan and other institutions. Most students were enrolled in the University of Michigan Summer Intensive Japanese Language Program. The program followed the same curriculum as the academic year language program at the University, but covered the material in ten weeks instead of 28. Ten credits were given for the course. In 1996 we supported ten students enrolled in the program. Four were from outside the University of Michigan. We also granted one fellowship to a UM student to study in Japan under the EAGLE program run out of the University of Illinois. In 1997 the number of applications was very low and the one summer fellowship we offered we then had to rescind when the language course for which the student applied was dropped by the Department of Asian Languages and Cultures. In 1998, the final summer of the fellowship program, we supported nine students in the summer program, including three students heading to internships in Japan at the end of the summer and two other non-University of Michigan students.

The number of academic year support fellowships we granted during this report period was below that offered in previous periods. In academic year 1996-97, we gave one fellowship, to Daniel Heilbrunn, a joint MBA/MA, Japanese Studies student. Aundrea Almond, a fellow MBA/MA student received a partial fellowship on the condition that she take several technology-related courses. Jill Gunderson, a joint MBA/MS in industrial and operations engineering student, was funded for a year with a cost-sharing grant from the Williams Foundation. Ms. Gunderson was also given additional JTMP support at various times to pay for Japanese language lessons.

Trying to best meet the needs of our students, we often used our funds interchangeably for PhD support fellowships and research assistantships during the grant period. James Lin, a graduate student in Industrial and Operations Engineering, was funded in 1996-97 to study issues of quality engineering, drawing heavily on Japanese practices, such as the Taguchi Method and quality function deployment. Mr. Lin left the University before completing his doctoral degree program.

Wilbur Chung, a doctoral student in International Business, was given funding that same year to pursue his research on the impact of Japanese auto transplants on the productivity of the US auto parts industry. Now on the faculty at New York University's Stern School of Business, Dr. Chung first examined the mechanisms by which foreign direct investment impacts on host country productivity via direct technology transfusion or via competition. His research shows that the positive impact of the Japanese transplants on US auto components firms' productivity is predominant due to the Japanese transplants increased competition in the US auto industry. Next, Dr. Chung observed that Japanese investment in the auto industry appears to cluster together. In economics, it is argued that the tendency is a manifestation of the agglomeration effect: clustering of similar businesses leads to development of a superior support system, including the creation of a pool of skilled workers and capable support firms. Some argue there is indirect positive spillover from the Japanese transplants on to US firms. When engineers are in the same location there is fruitful informal exchange of skills and information. Other people argue that direct linkage with the Japanese transplants lead to direct technology transfer. Dr. Chung was able to design an empirical approach to delineate all these effects.

Glenn Hoetker, a doctoral program student in International Business and Corporate Strategy at the Business School, was a research assistantship to pursue his dissertation research on *Produce vs. Purchase for Flat Panel Display Users*. The question of under what condition a firm should produce versus purchase the components which go into its final product is particularly pressing, particularly if the component is subject to great technological uncertainty, as in the case of Flat Panel Displays (FPDs). Manufacturers of products that incorporate flat panel displays must balance the advantages of producing their products in house with the increased possibility of being locked into an inferior technology. A firm's optimum strategy will change as technologies progress at uneven rates, but it is possible future strategies are strongly constrained by past strategic choices. Given this, and assuming firms are forward looking, three general questions arise:

- What is the relationship between the strategies firms take toward an FPD technology and that technology's relative degree of technological uncertainty?

- As the degree of uncertainty changes, to what degree does a firm's past strategic choices limit its ability to shift strategies accordingly?
- What are the performance implications of the first two questions, during times of gradual and of abrupt technological change?

A comparison of U.S. and Japanese FPD users offers insight into these questions. Japanese FPD users are more vertically integrated than those in the U.S. While this may be because the Japanese were early producers of FPDs, it may also be caused by deliberate strategies or by the pre-existing structure of Japanese firms. This study, part of the dissertation research of Glenn Hoetker, a doctoral student in Corporate Strategy, examines companies that fall within as well as outside the stereotype. In general Japanese firms are more likely than U.S. firms to conduct in-house R&D and production of technologies they intend to eventually outsource in order to provide superior understanding of the technologies. Have they followed this strategy in the case of FPDs and has it worked? The Japanese also tend to use cooperative R&D, especially through industry consortia. This project also examines the degree to which this has been done in the FPD industry and whether or not it has been more or less effective than cooperative efforts in the United States. This research project will probably finish in the year 2001. Mr. Hoetker was also given a smaller travel grant in 1997 to pursue research on the Fuji Film-Kodak dispute.

In 1996 we made two grants of \$2000 to doctoral students. James Mandiberg, then a candidate in a joint program on social work and organizational psychology and now on the faculty at the University of Wisconsin-Madison, was given support to pursue the Japan component of his research on "Technology Transfer when Organizational Form, Model, and Routine are the Technology." The initial question of the study was why would organizational technologies/models developed by one culture be copied at the expense of, and instead of, native technologies/models? The standard response that mimicking the models of others reduces uncertainty has been questioned by Eleanor Westney of MIT and by Mr. Mandiberg himself in other publications. Instead, Dr. Mandiberg offers three hypothesis: a) when cultures and economic developmental stages are similar, both the technology and the meaning of the technology are transferred successfully; b) when cultures are dissimilar, but economic developmental stages are similar, the technology is transferred but the meaning of technology is not; c) when both culture and economic developmental stages are dissimilar, the meaning of the technology is transferred but the actual technology is not. While Dr. Mandiberg pursued human service organization models in his research, the phenomenon it reflects occurs in a wide variety of business, non-profit, and governmental organizations. Organizational forms and routines such as Fordism and total quality management are examples of the same phenomenon that have had wide, technology independent effects, but effects that appear equivalent to those brought about by technology. Because of the great amount of bilateral transfer of technologies between Japan and the United States, this study is important in highlighting aspects of technology transfer that have not received much attention.

The second student, Heather Montgomery, recently received her doctorate in economics and has accepted a job at the Asia Development Bank in Tokyo. JTMP-support was used to conduct research used in two chapters of her dissertation: "Regulatory Capital and

Bank Lending in Japan" and "Macroeconomic Effects of Bank Credit in Japan". The first investigates empirically the effect of new capital adequacy regulations imposed under the Basel Accord of 1988 on bank lending in Japan. She used a panel of data from individual banks in Japan to look at how banks adjusted their portfolios in response to the regulatory change and whether there was a reduction in lending as a response. The second essay looks at this phenomenon on aggregate. It is an empirical study looking at whether Japan has truly experienced a credit crunch in the 1990s and whether the two economic downturns in this decade were the result of a credit crunch. So it is looking for reductions in lending on aggregate and then investigating whether these changes were transmitted to the "real economy", affecting GDP.

In addition to the three major categories of fellowships, the JTMP made other grants to students. Andrew Filip received funds to support his study at Nagoya University, which had just made an exchange agreement with the University of Michigan's College of Engineering. (This was in preparation for his internship at Nissan Aerospace.)

In 1997 we funded Aundrea Almond, an MBA/MA Japanese Studies student, and Rodney Wallace, an economy of Japan program PhD student, to pursue advanced Japanese language study at the Inter-University Center in Yokohama. While at the IUC, Mr. Wallace performed research on several topics, including a study of small industrial firms in the city of Oota-ku. Using contract theory, Mr. Wallace analyzed how firms were able to effectively leverage the strengths of small-firm corporate governance in Japan's present high-technology economy. He concluded that the strengths of small firms could best be used for production of 'niche' finished products and the creation of technology whose primary benefits can be realized within the small-firm environment win which there are few employees. He also conducted research, later used in his dissertation on firm strategy and the environment in which it is formed, on the Japanese pharmaceutical industry distribution system. In particular, he concentrated on the effects of the bidding system that the Japanese government instituted for public hospitals, showing that rather than increase the efficiency of the distribution system (as touted by American government representatives), the bidding system has *decreased* the efficiency.

Paul Carbonneau received a \$750 stipend to help offset the cost of adding the additional hours needed to take Technical Japanese and a \$5000 costsharing grant from the Williams Foundation in 1999. Jeffrey Schweinfus and Patrick Walker, graduate students in physical chemistry were granted \$700 each to travel to Japan to collaborate with Prof. Masao Doi and Hidehiro Oana at Nagoya University and to attend a conference in on high performance capillary electrophoresis in Kyoto.

In 1998 we funded four undergraduate engineering and computer science students to study in Japan. Dave Ostreicher attended Kyushu University and Laura Kieras, Douglas Lee, and Patricia Griffith studied at Nagoya University. We also gave Heather Montgomery a grant of \$3500 so she could remain in Japan to complete her doctoral research. Rachele Sampson was awarded up to \$3500 for the purchase of a database on Japanese patents needed for her dissertation research on the comparison of innovation in multinational enterprises to domestic firms. Robert Wilson received funds for travel to Japan for research on the Japanese petrochemical industry, as part of his MA thesis.

Technical Japanese Language Course and Textbook -- The JTMP supported the teaching of two technical Japanese language courses taught in the Department of Asian Languages and Cultures in 1996-97: Introduction to Technical Japanese at the third year level and Technical Japanese at the fourth year level. At about this time, nationwide enrollment in Japanese language courses dropped precipitously, and there were no longer enough students taking the course to justify devoting the resources to it. At about this same time, our technical Japanese language instructor, Keiko Unedaya, finished the technical Japanese language textbook upon which she had been working for the past few years. She submitted it to several publishers but with the drop in interest in Japanese language study, she was not able to find a publisher willing to take it on without a large subsidy. We are hopeful that if the current upswing in Japanese language study continues, we will eventually be able to get the book published.

IOE 425 John Shook and Mike Rother began this course on Manufacturing Strategies, focusing on lean manufacturing. It has since been taught by various adjunct faculty members, most of them current or retired manufacturing company executives, but also including Charles Standard, a former JTMP-supported graduate student now a manufacturing consultant. The course, each term filled over its 40-student capacity, teaches students about the manufacturing system started by the Toyota company and its implementation in Japanese and North American manufacturing firms. The class makes several field trips to visit American and Japanese transplant manufacturing companies. Students who have taken this course are much in demand with manufacturing firms for internships and permanent positions. Several students that received JTMP support at other points in their academic career, such as Paul Carbonneau, were teaching assistants for the course.

ADMINISTRATION

Jeffrey Liker, Associate Professor of Industrial and Operations Engineering was the grant principle investigator. He was the director of the program from 1996-97 and 1998-2000 and was a co-director in 1997. John Shook served as the Program's Director in 1997 and worked for the program on a 50% basis until November 1999. John Campbell, Professor of Political Science, and Brian Talbot, Professor of Operations Engineering, were Co-Directors. Mike Rother was employed on a 50% basis as Manufacturing Outreach Manager until November 1999. Heidi Tietjen was Associate Director in charge of administration throughout the grant. The JTMP also employed an office assistant and several part-time student assistants.

APPENDIX I: BIBLIOGRAPHY

By Jeffrey Liker (also see By Durward Sobek)

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APPENDIX II: STUDENTS INVOLVED IN INTERNSHIPS

Don Semones	Business/Japanese studies graduate student	University of Michigan	Aisin Seiki	Summer 1996
Paul Carbonneau	Industrial and Operations Engineering/Asian Studies undergraduate	University of Michigan	Aisin Seiki	Summer 1996
Max Miura	Aerospace Engineering	University of Michigan	Toyota Motor Manufacturing	Summer 1996
James Gutman	Economics/Political Science graduate student	University of Michigan	Long Term Credit Bank of Japan Research	Summer 1996
Naomi Hirano	Philosophy/Business undergraduate	University of Michigan	Herman Miller	Summer 1996
Heather Clement	Japanese Studies graduate student	University of Michigan	Aisin Seiki	Summer 1996
Aundrea Almond	Business/Japanese studies graduate student	University of Michigan	Aisin Seiki	Summer 1996
Jeffrey Pai	Computer Engineering	University of Michigan	Toyota	Summer 1996
Alan Hsu	Industrial and Operations Engineering undergraduate	University of Michigan	Walbro Japan	Summer 1996
Heather Montgomery	Economics graduate student	University of Michigan	Long Term Credit Bank of Japan Research	Summer 1996
Leonard Sanchez	Materials Science and Engineering undergraduate	University of Michigan	Sumitomo Metals	Summer 1996
Ruth Keyso	Japanese Studies graduate student	University of Michigan	J. Walter Thompson	Summer 1996
Andy Filip	Mechanical Engineering graduate student	University of Michigan	Nissan Aerospace	6 mo, 1996
Melissa Cheszek	Biology and environmental science undergraduate	Michigan State University	Econixe	1 yr, 1996-97
Greg Barnett	Electrical Engineering undergraduate	Michigan State University	Kokusai Electric	1 yr, 1996-97
Leon Kappler	Environmental Science undergraduate	Lake Superior State University	Asahi Glass	1 yr, 1997-98
Eric Westervelt	Electrical Engineering graduate student	University of Michigan	Hirata Corporation	9 mo, 1997-98
Kirby Hong	Electrical Engineering graduate student	University of Michigan	Oki Electric Co.	1 yr, 1997-98

Raymond Miller	Mechanical Engineering	University of Michigan	Zexel Corporation	6 mo. 1998-99
Howard Abbey	Computer Engineering	Michigan Technological University	NEC	1 yr. 1997-98
Brian Rennells	Electrical Engineering	Michigan State University	NTT	10 mo, 1998-99
David Ostreicher	Industrial & Operations Engineering undergraduate	University of Michigan	Toyota	1 month, 1999
Sandy Wong	Industrial & Operations Engineering undergraduate	University of Michigan	Fujitsu Chubu	1 yr, 2000-01
Albert Holmes	Computer Science/Japanese undergraduate	Morehouse University	Fujitsu Chubu	1 yr, 2000-01
Angela Knapp	Materials Science and Engineering undergraduate	University of Michigan	National Steel Corporation	Summer 2000
Charles Reeder	Computer Science/Japanese undergraduate	Earlham College	MACRO, Inc.	1 yr., 2000-01
Terry Spycher	Marketing undergraduate	University of Michigan - Flint	Zexel Inc. (now Robert Bosch)	1 yr., 2000-01
Ryo Sekine	Biology undergraduate	University of Michigan	Banyu-Tsukuba Research Institute	1 yr., 2000-01

APPENDIX III: STUDENTS GIVEN FINANCIAL SUPPORT

Student Name	School/Department/	Funding Purpose	Year
James Lin	University of Michigan, Industrial & Operations Engineering graduate student	Summer language study PhD Support	1996 1996-97
Andrew Filip	University of Michigan, Mechanical Engineering graduate student	Summer language study Study at Nagoya University, Fall	1996 1996
Jill Gunderson	University of Michigan, Industrial and Operations Engineering / Business School graduate student	Williams Fellowship Grant to support summer language study	1996-97 1996
Daniel Heilbrunn	University of Michigan, Business School/Japanese Studies graduate students	Summer language study Academic year fellowship	1996, 1998 1996-97
Aundrea Almond	University of Michigan, Business School/Japanese Studies graduate students	Partial Academic Year Fellowship Study at IUC	1996 1997-98
Glenn Hoetker	University of Michigan, International Business/Corporate Strategy doctoral student	PhD support and research expenses	1997-99
Robert Wilson	University of Michigan, Business School/Japanese Studies graduate student	Academic Year Fellowship Research support	1996-97 1998
Rod Ellicott	Washington University, Electrical Engineering undergraduate	Summer language study	1996
Warren Fernandez	University of Michigan, Electrical Engineering graduate student	Summer language study	1996
Roger Levy	University of Arizona, Mathematics undergraduate	Summer language study	1996
Peter Swanson	University of Michigan, Electrical Engineering, doctoral student	Summer language study	1996
Todd MacDermid	University of Michigan, Aerospace Engineering, doctoral student	Summer language study	1996
Jason Pearson	Princeton University Architecture graduate student	Summer language study	1996

Dorion Liston	Marshall University, Chemistry undergraduate	Summer language study	1996
William Sulzby	Auburn University, Chemical Engineering graduate student	Summer language study at EAGLE	1996
Paul Carbonneau	University of Michigan, Industrial and Operations Engineering / Japanese undergraduate and graduate student	Technical Japanese language incentive grant Williams Fellowship	1996 1999
Heather Montgomery	University of Michigan, Economics doctoral student	PhD research support	1997, 1999
Wilbur Chung	University of Michigan, International Business doctoral student	PhD Support	1997
James Mandiberg	University of Michigan, Social Work/ Organizational Psychology doctoral student	PhD research support	1997
Rod Wallace	University of Michigan, Economics doctoral student	PhD support for study at IUC	1997-98
Patrick Walker	University of Michigan Chemistry doctoral student	Travel grant	1997
Jeffrey Schwinefus	University of Michigan Chemistry doctoral student	Travel grant	1997
Durward Sobek	University of Michigan, Industrial and Operations Engineering doctoral	PhD support	Winter 1997
Eric Westervelt	University of Michigan Electrical Engineering doctoral student	Summer language study	1998
Raymond Miller	University of Michigan Mechanical Engineering graduate student,	Summer language study	1998
Hung Joon Chung	University of Michigan Mechanical Engineering doctoral student,	Summer language study	1998
Robert Duke	Grove City College Electrical Engineering undergraduate ,	Summer language study	1998
Kirby Hong	University of Michigan Electrical Engineering graduate student,	Summer language study	1998

Leon Kappler	Lake Superior State University Environmental Science undergraduate	Summer language study	1998
Erika Robertson	University of Michigan Biopsychology/Japanese undergraduate	Summer language study	1998
Rachelle Sampson	University of Michigan, International Business doctoral student	PhD direct research costs	1998
Daniel O'Brien	Boston University Electrical Engineering undergraduate	Summer language study	1998
Charles Standard	University of Michigan, Industrial & Operations Engineering graduate student	PhD Support	1998
Young Ro	University of Michigan , Industrial & Operations Engineering doctoral student	PhD Support	1998
Dave Ostreicher	University of Michigan, Industrial & Operations / Japanese undergraduate	Study at Kyushu University	1998-99
Doug Lee	University of Michigan, Civil Engineering undergraduate	Study at Nagoya University	1998-99
Laura Kieras	University of Michigan, Computer Science undergraduate	Study at Nagoya University	1998-99
Patricia Griffin	University of Michigan, Industrial & Operations Engineering undergraduate	Study at Nagoya University	1998-99